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FINAL REPORT

SINTERED IRON BRAKE CYLINDER PISTONS

BY

CHARLES B. JORDAN

NOVEMBER 1966

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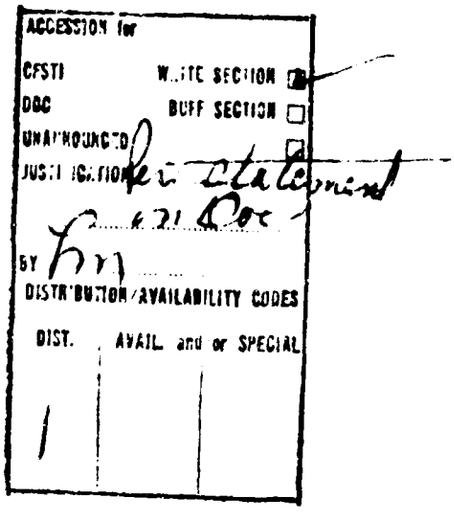
U. S. ARMY COATING & CHEMICAL LABORATORY
Aberdeen Proving Ground
Maryland



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SINTERED IRON BRAKE CYLINDER PISTONS

BY

CHARLES B. JORDAN

NOVEMBER 1966

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DEPARTMENT OF THE ARMY PROJECT NO.
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U.S. ARMY COATING AND CHEMICAL LABORATORY
ABERDEEN PROVING GROUND
MARYLAND

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ABSTRACT

This study consisted of a comparison of Sintered Iron Pistons versus Aluminum Pistons in hydraulic brake cylinders under conditions encountered in packaging, standby storage, stroking tests and vehicle operation.

While corrosion, staining and gumming are experienced with Aluminum Pistons, corrosion and staining are eliminated and gumming greatly reduced by Sintered Iron Pistons. Operational characteristics are improved with Sintered Iron Pistons as evidenced by reduced metal wear and almost total elimination of sediment in the Hydraulic Brake Fluid.

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I. INTRODUCTION

Aberdeen Proving Ground, Maryland, was authorized by AMC Directive AMCMS Code 5025.11.802 dated September 3, 1965 to conduct research on hydraulic brake fluids.

A parameter encountered during the development of brake fluids is the study of compatibility of the fluid with components of the brake system. The present military brake system contains several dissimilar metals, including tin, steel, aluminum, cast iron, brass and copper. Galvanic cells are present. These cells promote fluid oxidation, corrosion, and gum formation in brake cylinders in storage and on vehicles which are prepositioned or on standby storage. The removal of one of the more reactive metals from the brake system decreases the potential. Therefore, replacing the aluminum pistons with a treated sintered iron piston holds real promise in reducing or eliminating galvanic action caused by untreated aluminum.

A number of Sintered Iron Pistons were obtained during their development stage and were examined for compatibility with Hydraulic Brake Fluids. The tests conducted on these pistons are included in this report.

II. DETAILS OF TEST

A. Sintered Iron Pistons

The sintered iron pistons were supplied by Delco Moraine Division of GMC and are made from iron powder and small quantities of Babbitt. They are sintered, sized, and impregnated with an inhibited synthetic preservative lubricant which is compatible with conventional brake fluids. The porosity of the piston is approximately 20%. The powder is compressed until the final product has a Brinell hardness of about 86. This hardness approximates that of standard aluminum pistons. Exudation of the preservative oil supplies lubrication as well as increased corrosion protection.

B. Tests Conducted

1. Packaging Tests - Brake cylinders containing sintered iron pistons were packaged with 4 different brake fluids and stored in an unheated warehouse. Duplicate cylinders were packaged with aluminum pistons. Periodic examinations were made by removing the right hand piston from each cylinder and replacing it after examination. If a cylinder showed excessive corrosion or gumming, it was discarded and the length of storage time recorded.

The following fluids were used in this test as packaging fluids:

a. Fluid meeting Federal Specification VV-B-680 (Commercial)

b. Fluid meeting Military Specification MIL-H-13910 (Reference formulation)

c. Fluid meeting Military Specification MIL-H-13910 (Commercial)

d. Fluid meeting Military Specification MIL-P-46046, Composition 3

2. Simulated Standby Storage Tests - This series of tests involved the use of systems simulating vehicle brake systems. These systems are in the open and subjected to weather and temperature conditions prevalent in this locality. Corrosion and gumming of brake fluids are normally accelerated in these systems and correlates with that found in vehicles on standby storage or prepositioned status.

Four systems each consisting of one master cylinder and two wheel cylinders were set up. Two systems contained sintered iron wheel cylinder pistons and two contained aluminum pistons. The fluids used were:

a. Fluid meeting Federal Specification VV-B-680 (Commercial)

b. Fluid meeting Military Specification MIL-P-46046, Composition 1.

3. Stroking Tests - Eight stroking tests were conducted with sintered iron pistons using six different brake fluids. Comparative tests were conducted with aluminum pistons. Tests were conducted on specification stroking equipment for 300,000 strokes at 158°F.

4. Operational Field Tests - Test brake cylinders were installed on nine facility vehicles in use at Yuma Proving Ground, Arizona. Included in the test were three- 1/4 ton, three- 3/4 ton, and three- 2-1/2 ton vehicles. Three of the vehicles (one of each class) were equipped with sintered iron wheel cylinder pistons, three with standard aluminum pistons, and three were equipped with electroless nickel brake cylinders. All other brake components were standard items. Brake lines were flushed and filled with all-weather brake fluid meeting MIL-H-13910. Each vehicle was examined monthly to detect fluid leaks or brake malfunction. Brake applications and mileage figures were recorded.

After one year's service ony cylinder from each vehicle involving sintered iron pistons and aluminum pistons was removed, examined, photographed and reinstalled on the vehicles. The test on the three vehicles equipped with electroless nickel was discontinued.

III. RESULTS OF TEST

A. Packaging Tests

Results of inspections after one, two, and three years storage are included in Table I. It was found that the use of sintered iron pistons reduced or eliminated stain, corrosion, and gum formation regardless of the packaging fluid used. Those cylinders packaged with aluminum pistons,and operational fluids,were discarded after one or two years storage due to their inoperable condition. Stain and slight to moderate gum deposits had formed in the cylinders containing aluminum pistons and preservative fluid, MIL-P-46046. All cylinders with sintered iron pistons were still satisfactory after three years.

B. Simulated Standby Storage Tests

Six month inspections were made by opening the boot of one wheel cylinder in each test. The cylinders containing the sintered iron pistons and the operational fluid showed a slight amount of a "greasy deposit". Those containing the sintered iron pistons and the preservative fluid were in perfect condition. The cylinders containing the aluminum pistons and operational fluid showed moderate moist deposits, slight stain and incipient corrosion but were operable. Those containing aluminum pistons and the preservative fluid showed slight deposits but no stain or corrosion. All systems remain in test

C. Stroking Tests

All stroking tests involving sintered iron pistons gave superior results. No malfunctioning occurred. Cylinder walls, pistons, and cups were in excellent condition. All residual brake fluid was free of debris and sedimentation. Comparable tests involving aluminum pistons showed slight to moderate scoring of pistons and cylinder walls and slight chipping and scuffing of cups. Fluid from the tests showed a moderate amount of black debris and slight to excessive amounts of sedimentation. Two of the six fluids tested with aluminum pistons failed the stroking requirements of VV-B-680. All fluids tested with sintered iron passed specification requirements.

D. Operational Field Tests

Results of the one year inspection of the cylinders in the operational field tests at Yuma Proving Ground are included in Table II.

All brake cylinders and pistons in the sintered iron test were in perfect condition. In the cylinders containing aluminum pistons, moderate quantities of deposits had formed. Slight pitting was evident beneath the deposits on the pistons and cylinder wall. The cylinders were operational but trouble could occur in future operation.

Replacement cylinders for this field test had been packaged with the operational fluid and stored in a wooden box in the open at Yuma Proving Ground. These cylinders were inspected after one year's storage. The cylinders containing sintered iron pistons showed slight greasy deposits but no stains or corrosion. Those containing aluminum pistons were operational but showed moderate hard dry deposits with slight pitting on the pistons and very slight pitting on the cylinder walls.

IV. CONCLUSIONS AND DISCUSSION

This application of powdered metallurgy and impregnation imparts chemical stability to this area of the brake system by eliminating a troublesome galvanic cell. As a result, corrosion, staining, and gumming were reduced or eliminated in all tests involving sintered iron pistons versus aluminum pistons. Operational characteristics were improved, as evidenced by reduced metal wear and almost total elimination of fluid sediment. All systems containing sintered iron pistons were superior to those containing aluminum pistons.

The replacement in military vehicle brake systems of aluminum pistons with sintered iron pistons will allow a tremendous advance in the areas of packaging, and storing of brake parts and prepositioning vehicles. Brake system maintenance during operation will be less frequent and brake malfunction will be reduced.

The sintered iron pistons are readily available and cost no more than anodized aluminum pistons.

General Motors Corporation started using sintered iron pistons in some of their 1964 automobiles and at the present time employ them in all GMC vehicles. They have reported that their performance has been superior.

V. RECOMMENDATIONS

Based on the findings reported herein, it is recommended that aluminum pistons in the brake wheel cylinders of all military vehicles be replaced with sintered iron pistons in the earliest possible time-frame.

VI. REFERENCES

A. Authority: AMC Directive, AMCMS, Code 5025.11.802 dated Sept. 3, 1965.

B. Federal Specification, VV-B-680, Brake Fluid Automotive, dated Dec. 15, 1964.

C. Military Specification, MIL-H-13910A, Hydraulic Fluid, Non-Petroleum Base, Automotive Brake, All-Weather, dated May 15, 1963.

D. Military Specification, MIL-P-46046, Preservative Fluid Automotive Brake System and Components, dated August 26, 1964.

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APPENDIX A

TABLE I

WAREHOUSE PACKAGING AND STORAGE OF BRAKE WHEEL CYLINDERS WITH SINTERED IRON PISTONS

	Fluid	Sintered Iron Pistons	Aluminum Pistons
One Year Inspection			
1.	VV-B-680 (Synthetic Base)	No stain, corrosion or gum.	Piston frozen in Cylinder-Heavy gum deposits-Cylinder discarded.
2.	MIL-H-13910A (All-Weather-Reference formulation)	No stain, corrosion or or gum.	Slight etching, Slight stain, Moderate gum deposits.
3.	MIL-H-13910A (All-Weather, Commercial)	Slight stain, no corrosion or gum.	Piston frozen in Cylinder, Heavy gum deposits - Cylinder discarded.
4.	MIL-P-46046 (Composition 3)	No stain, corrosion or gum.	Slight stain, Slight gum deposits.
Two Year Inspection			
1.	VV-B-680	No stain, corrosion or gum.	---
2.	MIL-H-13910A (Reference formulation)	No stain, corrosion, slight greasy deposits.	Slight pitting, Moderate stain, Heavy gum deposits-Cylinder discarded.
3.	MIL-H-13910A (Commercial)	Slight stain, no corrosion, slight greasy deposits.	---
4.	MIL-P-46046	No stain, corrosion or or gum.	Slight stains, Slight gum deposits, no corrosion.

TABLE I - Cont'd.

WAREHOUSE PACKAGING AND STORAGE OF BRAKE WHEEL CYLINDERS WITH SINTERED IRON PISTONS

Three Year Inspection

Fluid	Sintered Iron Pistons	Aluminum Pistons
1. VV-B-680	No stain or corrosion, slight to moderate greasy deposits.	---
2. MIL-H-13910A (Reference Formulation)	No stain or corrosion, slight greasy deposits.	---
3. MIL-H-13910A (Commercial)	Slight stain, no corrosion, slight greasy deposits.	---
4. MIL-P-46046	No stain, corrosion or gum.	Slight stain, moderate gum deposits, no corrosion.

TABLE II

ONE YEAR INSPECTION - SINTERED IRON VERSUS ALUMINUM PISTONS
YUMA PROVING GROUND, ARIZONA

Vehicle	Type of Piston	Miles Operated	Brake Applic's	Inspection Results
1/4 ton M151 Reg. No. 2G4871	Aluminum	5082	8410	Pistons-grayish black deposits, slight scoring. Cylinder Wall- Normal wear areas Cups - OK Fluid - Black Sediment.
1/4 ton M151 Reg. No. 2F5821	Sintered Iron	6007	32120	Pistons - OK Cyl Wall - Normal Wear areas Cups - OK Fluid - Clear
3/4 ton M-37 Reg. No. 3C1255	Aluminum	6523	34532	Pistons - Mod Hard dry deposits, Slight pitting, Cyl Wall - Slight gritty deposits, Cup - OK Fluid - Black Sedimentation
3/4 ton M-37 Reg. No. 3C1257	Sintered Iron	6962	20972	Pistons - OK Cyl Wall - Normal Wear Areas Cups - OK Fluid - Clear
2-1/2 ton M-49 Reg. No. 8015824	Aluminum	1208	3478	Pistons - Slight dry deposits, slight gouged area on one piston. Cyl Wall - Very slight to slight pitting. Cup - OK Fluid - Slight black sedimentation.

TABLE II - Cont'd.

ONE YEAR INSPECTION - SINTERED IRON VERSUS ALUMINUM PISTONS
YUMA PROVING GROUND, ARIZONA

Vehicle	Type of Piston	Miles Operated	Brake Applic's	Inspection Results
2-1/2 ton M-35 USA 4C9839	Sintered Iron	607	1979	Pistons - OK Cyl Wall - OK Cups - OK Fluid - Clear

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